Health and Economic Impact of Breast Cancer Mortality in Young Women, 1970–2008

Donatus U. Ekwueme, PhD, MS, Gery P. Guy Jr., PhD, MPH, Sun Hee Rim, MPH,
Arica White, PhD, MPH, Ingrid J. Hall, PhD, MPH, Temeika L. Fairley, PhD, MPH,
Hazel D. Dean, ScD, MPH

Appendix A

METHODS

Annual percent change

Joinpoint regression software (version 3.4.3) was used to examine the annual percentage change (APC) in breast cancer mortality rates among young women. This modeling software uses a Monte Carlo permutation test to identify points where the direction or magnitude of the trend changes and fits the model containing the fewest number of trend segments.[1] The analysis starts with the minimum number of joinpoints (e.g., 0 joinpoints = a straight line) and tests whether each joinpoint is statistically significant and must be added to the model. In the final model, for each joinpoint that informs a statistically significant change in trend, an APC is estimated by means of log-linear models assuming a Poisson distribution. Formally, the regression model for APC can be expressed as: $y = mx + b$, where $y =$ mortality rate and $x =$ calendar year, and the estimated APC is expressed as APC $= \{(Exp(m)-1\} \times 100$. The model tests the hypothesis that the APC is equal to zero, indicating that the breast cancer mortality rate in young women is not increasing or decreasing. However, if the estimated APC values are statistically significantly different from zero, this indicates evidence of change (i.e., increasing trends) in death rates in young women during a specified calendar period APC values that are not statistically significant indicate evidence of stability in the death rates during the specified calendar period. Trends in mortality rates were calculated by racial/ethnic categories, age groups, and geographic regions. Statistical significance was assessed by using a 2-sided t test with $p < 0.05$.

Estimating Years of Potential Life Lost

Years of potential life lost (YPLL) was used to quantify the magnitude of breast cancer burden among young women by using the following steps. First, the U.S. life tables from 1970 through 2008 were used to obtain average life expectancy (LE) for women across racial/ethnic categories. From 1970 through 1979, the calculated average LE was 76.1 years for all races/ethnicities, 76.6 years for whites, and 71.6 years for blacks.[2] Similarly, the average LE from 1980–1989, 1990–1999, 2000–2008, and 1970–2008 and by racial/ethnic groups were calculated in an analogous manner. Second, because of the variations in the average LE among racial/ethnic categories, using an arbitrarily maximum age cut-off of 70 or 75 years as have been done in past studies may not be appropriate.[3–5] The calculated average LE was treated as a random variable with a probability distribution values ranging from 71.6 years (minimum) to 76.1 years (most likely) to 76.6 years (maximum) value. Third, the constructed probability distribution was used to conduct simulations using the Monte Carlo method.[6,7] Fourth, we calculated average expected number of years of life remaining at the age of death by subtracting the value obtained from the probability distribution by the mid-point of the age group, assuming uniform distribution of deaths within age groups.[4] Finally, YPLL was calculated by taking the product of the average expected number of years of life remaining at the age of death by the number of deaths in each age group. The calculation was

performed for each of the five time periods: 1970–1979, 1980–1989, 1990–1999, 2000–2008, and 1970–2008.

The analysis was conducted using @Risk® software (version 4.5 Palisade Corp., Newfield, NY, USA, 2008) with Monte Carlo simulation methods. A total of 1,000 independent simulation runs were performed. The convergence monitoring option in the software was used to ensure that this number of simulations was sufficient for accurate and stable results. Using the output from the 1,000 simulation runs, the following outcomes including their corresponding 95% confidence intervals (CIs) were calculated: 1) total number of YPLL, 2) YPLL rates per 100,000 women, and 3) YPLL per death.

Estimating the Value of Mortality-Related Productivity Losses

The value of productivity loss from premature mortality was used to quantify the impact of breast cancer burden among young women. The estimates followed previously published methods that have estimated the value of lifetime mortality-related productivity losses.[8–10] An incidence-based costing method was used to value the lost lifetime productivity of young women who died of breast cancer in 2008. In this method, we estimated the value of lost lifetime productivity of those who died of breast cancer in 2008 rather than prevalence-based approach—the value of lost productivity in 2008 of those who died of breast cancer in 2008 or in previous years and who otherwise would have been alive in 2008. Using the human capital approach,[9] the value of productivity losses was estimated as the product of the number of deaths in 2008 and the present value of forgone future lifetime earnings (PVFLE) based on an individual woman's remaining years of life. The estimates were stratified by racial/ethnic categories and by age group. The human capital approach values labor productivity acquired through an investment in education, on-the-job training, work experience, and the value of nonwage labor productivity an individual performed in the household.[11]

Using published data,[12] two components of PVFLE were calculated—the total lifetime production and the market production—to estimate separately the value of productivity losses. The total lifetime production includes earnings and household productivity while the market production includes only earnings in the labor market. The two components of the PVFLE estimate took into account factors like life expectancy, labor force participation rate, and future growth rate in productivity. In addition to these factors, total production includes imputed value of housekeeping services (e.g., cooking, cleaning, and child care). In estimating the PVFLE, a 3% discount rate was applied. The discount rate was used to convert future earnings to present value for women who died due to breast cancer.[13] Further, the estimated PVFLE was varied between a 0% and a 5% discount rate, respectively. In addition to estimating the total PVFLE lost because of breast cancer mortality, cost of premature death on an individual level was also estimated. The estimated PVFLE were appraised for uncertainty by using the lower and upper bounds of the 95% CI of the death rates. All estimated PVFLE were converted to 2008 U.S. dollars using the consumer price index, available at http://www.bls.gov/cpi/data.htm.

Sensitivity Analysis

The estimated sensitivity analysis of the PVFLE is presented in Appendix Table 5. Among all racial/ethnic groups and among whites and blacks separately, the estimated lower and upper range of productivity losses were remarkably close to the estimates presented in Table 4, which indicate very little variation in mortality rates among women age 20–49 years. For example, in all racial/ethnic groups, the estimated total lifetime productivity losses ranged from $5.22 to $5.69 billion with an estimated baseline of $5.49 billion. The estimates for market productivity losses due to premature breast cancer deaths followed the same pattern.

Appendix A References

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Appendix B

Breast cancer mortality rates per 100,000 women by race, age group, and geographic region, U.S., 1970–2008

All race/ ethnicity	1970–1979		1980–1989		1990–1999		2000–2008	
	Rate[a] (95% CI)[b]	RR[c] (95% CI)	Rate (95% CI)	RR (95% CI)	Rate (95% CI)	RR (95% CI)	Rate (95% CI)	RR (95% CI)
20–29 years	0.87 (0.83, 0.92)		0.69 (0.65, 0.72)		0.58 (0.54, 0.61)		0.42 (0.39, 0.45)	
South	0.97 (0.89, 1.05)	1.00	0.76 (0.70, 0.83)	1.00	0.70 (0.64, 0.76)	1.00	0.51 (0.45, 0.56)	1.00
Northeast	0.87 (0.78, 0.97)	0.90 (0.79, 1.04)	0.63* (0.55, 0.70)	0.82* (0.71, 0.95)	0.53* (0.47, 0.61)	0.77* (0.65, 0.90)	0.32* (0.26, 0.39)	0.63* (0.50, 0.79)
Midwest	0.85 (0.77, 0.94)	0.88 (0.77, 1.00)	0.70 (0.63, 0.77)	0.91 (0.80, 1.04)	0.55* (0.48, 0.62)	0.78* (0.67, 0.91)	0.43 (0.36, 0.50)	0.85 (0.70, 1.02)
West	0.75* (0.66, 0.85)	0.78* (0.67, 0.91)	0.61* (0.54, 0.69)	0.80* (0.69, 0.93)	0.45* (0.39, 0.52)	0.64* (0.54, 0.76)	0.34* (0.29, 0.40)	0.68* (0.55, 0.83)
30–39 years	9.35 (9.18, 9.53)		9.32 (9.17, 9.46)		7.39 (7.28, 7.51)		5.73 (5.63, 5.85)	
South	9.43 (9.13, 9.74)	1.00	9.73 (9.48, 9.99)	1.00	8.24 (8.04, 8.45)	1.00	6.32 (6.13, 6.52)	1.00
Northeast	9.79 (9.43, 10.16)	1.04 (0.99, 1.09)	9.53 (9.22, 9.85)	0.98 (0.94, 1.02)	7.24* (6.99, 7.50)	0.88* (0.84, 0.92)	5.49* (5.24, 5.74)	0.87* (0.82, 0.92)
Midwest	9.44 (9.11, 9.79)	1.00 (0.95, 1.05)	9.37 (9.08, 9.67)	0.96 (0.92, 1.00)	7.22* (6.98, 7.46)	0.88* (0.84, 0.91)	5.71* (5.47, 5.95)	0.90* (0.86, 0.96)
West	8.54* (8.16, 8.93)	0.91* (0.86, 0.96)	8.37* (8.08, 8.68)	0.86* (0.82, 0.90)	6.38* (6.16, 6.61)	0.77* (0.74, 0.81)	5.04* (4.82, 5.26)	0.80* (0.76, 0.84)
40–49 years	33.01 (32.68, 33.33)		29.99 (29.69, 30.29)		25.81 (25.58, 26.04)		19.05 (18.86, 19.24)	
South	30.80 (30.25, 31.36)	1.00	29.43 (28.93, 29.93)	1.00	27.26 (26.86, 27.66)	1.00	20.72 (20.39, 21.05)	1.00
Northeast	37.55* (36.85, 38.25)	1.22* (1.19, 1.25)	32.18* (31.52, 32.84)	1.09* (1.06, 1.12)	26.17* (25.66, 26.69)	0.96* (0.94, 0.98)	18.44* (18.02, 18.87)	0.89* (0.87, 0.92)
Midwest	32.84* (32.21, 33.47)	1.07* (1.04, 1.09)	30.65* (30.05, 31.27)	1.04* (1.01, 1.07)	25.21* (24.75, 25.69)	0.93* (0.90, 0.95)	18.77* (18.37, 19.17)	0.91* (0.88, 0.93)
West	30.86 (30.12, 31.62)	1.00 (0.97, 1.03)	27.71* (27.07, 28.36)	0.94* (0.91, 0.97)	23.77* (23.30, 24.25)	0.87* (0.85, 0.89)	17.20* (16.82, 17.59)	0.83* (0.81, 0.85)
20–49 years	15.15 (15.02, 15.28)		14.02 (13.90, 14.13)		11.84 (11.75, 11.93)		8.83 (8.76, 8.91)	
South	14.43 (14.20, 14.65)	1.00	13.98 (13.79, 14.18)	1.00	12.68 (12.52, 12.84)	1.00	9.65 (9.52, 9.79)	1.00
Northeast	16.90* (16.62, 17.18)	1.17* (1.15, 1.20)	14.84* (14.59, 15.10)	1.06* (1.04, 1.09)	11.90* (11.70, 12.11)	0.94* (0.92, 0.96)	8.50* (8.33, 8.68)	0.88* (0.86, 0.90)

Appendix D

Total number of deaths and years of potential life lost due to breast cancer mortality among young women by race/ethnicity and age group, U.S., 1970–2008

| | | YPLL[b] | | |
Age group (Years)	Total number of deaths	Total number (95% CI)	Rate[a] (95% CI)	Per death[a] (95% CI)
1970–1979				
All race/ethnicity				
20–29	1,508	75,787 (75,682, 75,893)	42.20 (42.14, 42.25)	—
30–39	11,633	468,307 (467,493, 469,120)	356.33 (355.71, 356.95)	—
40–49	40,227	1,217,138 (1,214,325, 1,219,951)	1020.47 (1,018.11, 1,022.83)	—
20–49	53,368	1,761,232 (1,757,499, 1,764,964)	409.30 (408.43, 410.16)	33.00 (32.93, 33.07)
Whites				
20–29	1,205	60,559 (60,475, 60,644)	39.28 (39.22, 39.33)	—
30–39	9,657	388,759 (388,084, 389,435)	342.36 (341.76, 342.95)	—
40–49	34,941	1,057,201 (1,054,757, 1,059,644)	1012.82 (1,010.48, 1,015.16)	—
20–49	45,803	1,506,519 (1,503,316, 1,509,723)	404.86 (404.00, 405.72)	32.89 (32.82, 32.96)
Blacks				
20–29	289	14,524 (14,504, 14,544)	66.70 (66.60, 66.79)	—
30–39	1850	74,475 (74,346, 74,604)	498.12 (497.26, 498.99)	—
40–49	4964	150,194 (149,847, 150,542)	1,174.18 (1,171.46, 1,176.89)	—
20–49	7,103	239,194 (238,697, 239,690)	483.03 (482.03, 484.04)	33.67 (33.60, 33.74)
1980–1989				
All race/ethnicity				
20–29	1,468	77,197 (77,109, 77,286)	36.83 (36.79, 36.88)	—
30–39	16,364	696,888 (695,903, 697,873)	374.28 (373.75, 374.81)	—
40–49	39,283	1,280,101 (1,277,737, 1,282,466)	972.44 (970.64, 974.23)	—
20–49	57,115	2,054,187 (2,050,750, 2,057,625)	389.48 (388.83, 390.14)	35.97 (35.91, 36.03)
Whites				
20–29	1,065	56,005 (55,941, 56,069)	32.16 (32.12, 32.19)	—
30–39	13,039	555,288 (554,503, 556,072)	354.34 (353.84, 354.84)	—
40–49	32,577	1,061,576 (1,059,615, 1,063,537)	943.23 (941.48, 944.97)	—
20–49	46,681	1,672,868 (1,670,058, 1,675,678)	377.26 (376.63, 377.89)	35.84 (35.78, 35.90)
Blacks				
20–29	377	19,825 (19,802, 19,848)	69.68 (69.60, 69.76)	—
30–39	3040	129,463 (129,280, 129,646)	573.48 (572.67, 574.29)	—
40–49	6115	199,267 (198,899, 199,636)	1,342.26 (1,339.78, 1,344.74)	—
20–49	9,532	348,556	529.15	36.57

Age group (Years)	Total number of deaths	YPLL[b]		Per death[a] (95% CI)
		Total number (95% CI)	Rate[a] (95% CI)	
		(347,982, 349,130)	(528.28, 530.02)	(36.51, 36.63)

1990–1999

All race/ethnicity

Age group (Years)	Total number of deaths	Total number (95% CI)	Rate[a] (95% CI)	Per death[a] (95% CI)
20–29	1,157	61,479 (61,390, 61,569)	32.14 (32.09, 32.18)	—
30–39	15,843	683,416 (682,188, 684,643)	310.91 (310.36, 311.47)	—
40–49	48,283	1,599,942 (1,596,201, 1,603,683)	851.70 (849.71, 853.69)	—
20–49	65,283	2,344,837 (2,339,779, 2,349,895)	391.48 (390.63, 392.32)	35.92 (35.84, 36.00)

Whites

20–29	778	41,340 (41,280, 41,401)	27.08 (27.04, 27.12)	—
30–39	11,741	506,469 (505,559, 507,378)	282.58 (282.07, 283.09)	—
40–49	38,096	1,262,378 (1,259,426, 1,265,330)	806.75 (804.86, 808.64)	—
20–49	50,615	1,810,187 (1,806,265, 1,814,109)	370.65 (369.85, 371.46)	35.76 (35.69, 35.84)

Blacks

20–29	346	18,385 (18,359, 18,412)	65.70 (65.60, 65.79)	—
30–39	3,696	159,433 (159,147, 159,720)	540.15 (539.18, 541.12)	—
40–49	8,903	295,017 (294,327, 295,706)	1,308.84 (1,305.78, 1,311.90)	—
20–49	12,945	472,835 (471,832, 473,838)	590.73 (589.48, 591.98)	36.53 (36.45, 36.60)

2000–2008

All race/ethnicity

20–29	740	40,237 (40,191, 40,284)	22.62 (22.60, 22.65)	—
30–39	10,512	466,469 (465,810, 467,128)	251.44 (251.09, 251.80)	—
40–49	38,848	1,335,396 (1,332,962, 1,337,831)	663.12 (661.91, 664.33)	—
20–49	50,100	1,842,103 (1,838,963, 1,845,243)	326.18 (325.63, 326.74)	36.77 (36.71, 36.83)

Whites

20–29	468	25,447 (25,418, 25,477)	18.39 (18.37, 18.41)	—
30–39	7,312	324,469 (324,011, 324,928)	222.41 (222.10, 222.73)	—
40–49	28,678	985,804 (984,007, 987,601)	604.43 (603.33, 605.53)	—
20–49	36,458	1,335,721 (1,333,437, 1,338,006)	298.57 (298.06, 299.09)	36.64 (36.57, 36.70)

Blacks

20–29	244	13,267 (13,252, 13,283)	48.97 (48.92, 49.03)	—
30–39	2768	122,830 (122,656, 123,003)	464.79 (464.14, 465.45)	—
40–49	8765	301,297 (300,747, 301,846)	1,132.17 (1,130.10, 1,134.23)	—
20–49	11,777	437,394 (436,656, 438,132)	545.85 (544.92, 546.77)	37.14 (37.08, 37.20)

1970–2008

All race/ethnicity

20–29	4,873	255,822	33.73	—

Age group (Years)	Total number of deaths	YPLL[b] Total number (95% CI)	Rate[a] (95% CI)	Per death[a] (95% CI)
		(255,565, 256,078)	(33.70, 33.77)	
30–39	54,352	2,309,837 (2,306,971, 2,312,704)	319.50 (319.11, 319.90)	—
40–49	166,641	5,415,457 (5,406,668, 5,424,245)	845.98 (844.60, 847.35)	—
20–49	225,866	7,981,115 (7,969,204, 7,993,027)	376.21 (375.65, 376.77)	35.34 (35.28, 35.39)
Whites				
20–29	3,516	184,582 (184,397, 184,768)	29.80 (29.77, 29.83)	—
30–39	41,749	1,774,240 (1,772,038, 1,776,442)	298.00 (297.63, 298.37)	—
40–49	134,292	4,364,192 (4,357,110, 4,371,274)	813.45 (812.13, 814.77)	—
20–49	179,557	6,323,015 (6,313,545, 6,332,484)	361.05 (360.51, 361.59)	35.21 (35.16, 35.27)
Blacks				
20–29	1,256	65,937 (65,871, 66,003)	62.62 (62.55, 62.68)	—
30–39	11,354	482,520 (481,921, 483,119)	516.23 (515.59, 516.87)	—
40–49	28,747	934,213 (932,697, 935,730)	1,216.58 (1,214.61, 1,218.56)	—
20–49	41,357	1,482,670 (1,480,489, 1,484,852)	538.05 (537.26, 538.84)	35.85 (35.80, 35.90)

[a] Rates are per 100,000 women.

[b] YPLL per death was calculated by dividing the estimated number of YPLL by the number of deaths that occurred prematurely.

YPLL, years of potential life lost.

Appendix E

Present value of future lifetime productivity losses due to breast cancer mortality among young women aged 20–49 years by race/ethnicity and age group, U.S., 2008

Race/ethnicity by age group	Discounted total cost ($ x 10^6)		Discounted total cost per death ($ x 10^6)	
	Total production	Market production only	Total production	Market production
Discount[a]	3% (5–0%)	3% (5–0%)	3% (5–0%)	3% (5–0%)
All race/ethnicity				
20–29	$121.1 ($84.3–244.3)	$70.3 ($25.5–130.2)	$1.53 ($1.07–3.09)	$0.89 ($0.32–1.65)
30–39	$1,324.9 ($989.6–2,313.8)	$766.1 ($592.8–1,208.3)	$1.34 ($0.99–2.35)	$0.78 ($0.60–1.23)
40–49	$3,002.6 ($3,156.2–6,247.0)	$2,221.3 ($1,847.6–3,056.4)	$1.03 ($0.81–1.60)	$0.57 ($0.47–0.78)
20–49	$5,448.6 ($4,230.1–8,805.1)	$3,057.6 ($2,465.9–4,394.9)	$1.10 ($0.85–1.77)	$0.62 ($0.50–0.89)
Whites				
20–29	$85.8 ($59.8–173.2)	$49.8 ($18.1–92.3)	$1.52 ($1.06–3.09)	$0.88 ($0.32–1.63)
30–39	$894.5 ($721.0–1,445.9)	$517.2 ($400.2–815.7)	$1.35 ($1.08–2.17)	$0.78 ($0.60–1.23)
40–49	$2,940.1 ($2,138.4–4,588.7)	$1,631.6 ($1,357.2–2,245.1)	$1.03 ($0.81–1.60)	$0.57 ($0.47–0.78)
20–49	$3,920.4 ($3,099.1–6,207.7)	$2,198.7 ($1,775.4–3,153.1)	$1.09 ($0.86–1.73)	$0.61 ($0.50–0.88)
Blacks				
20–29	$32.2 ($22.4–65.0)	$18.7 ($6.8–34.6)	$1.52 ($1.06–3.07)	$0.88 ($0.32–1.64)
30–39	$371.3 ($277.3–648.3)	$214.7 ($166.1–338.6)	$1.35 ($1.00–2.35)	$0.78 ($0.60–1.23)
40–49	$919.8 ($725.3–1,435.6)	$510.5 ($424.6–702.4)	$1.03 ($0.81–1.60)	$0.57 ($0.47–0.78)
20–49	$1,323.2 ($1,025.0–2,148.9)	$743.8 ($597.5–1,075.5)	$1.11 ($0.86–1.80)	$0.62 ($0.50–0.90)

[a] The discount rate converts future earnings of the deceased to present value by estimating the effect of inflation. We applied a 3% discount rate and varied our estimates between a 0% and a 5% discount rate.

Appendix F

Sensitivity analysis of the present value of discounted future lifetime productivity losses due to breast cancer mortality among young women aged 20–49 years

	Discounted total production cost (95% CI)		Discounted total market cost (95% CI)	
	Production ($ x 1 million)	Per death ($ x 1 million)	Market ($ x 1 million)	Per death ($ x 1 million)
All race/ethnicity				
Lower mortality rate	$5216.8	$1.08	$2926.4	$0.59
Upper mortality rate	$5688.5	$1.11	$3193.5	$0.63
White				
Lower mortality rate	$3726.6	$1.07	$2089.0	$0.58
Upper mortality rate	$4126.6	$1.11	$2315.4	$0.65
Black				
Lower mortality rate	$1209.6	$1.07	$679.4	$0.57
Upper mortality rate	$1448.8	$1.15	$815.0	$0.68

All race/ethnicity	1970–1979		1980–1989		1990–1999		2000–2008	
	Rate^a (95% CI)^b	RR^c (95% CI)	Rate (95% CI)	RR (95% CI)	Rate (95% CI)	RR (95% CI)	Rate (95% CI)	RR (95% CI)
Midwest	15.11* (14.86, 15.37)	1.05* (1.02, 1.07)	14.27 (14.03, 14.51)	1.02 (1.00, 1.04)	11.56* (11.38, 11.75)	0.91* (0.89, 0.93)	8.73* (8.56, 8.89)	0.90* (0.88, 0.93)
West	14.07 (13.78, 14.37)	0.98 (0.95, 1.00)	12.86* (12.61, 13.11)	0.92* (0.90, 0.94)	10.73* (10.55, 10.92)	0.85* (0.83, 0.86)	7.92* (7.76, 8.07)	0.82* (0.80, 0.84)
Whites								
20–29 years	0.81 (0.77, 0.86)		0.60 (0.56, 0.63)		0.48 (0.45, 0.52)		0.34 (0.31, 0.37)	
South	0.85 (0.77, 0.94)	1.00	0.61 (0.54, 0.67)	1.00	0.50 (0.44, 0.56)	1.00	0.39 (0.33, 0.45)	1.00
Northeast	0.82 (0.73, 0.93)	0.96 (0.82, 1.13)	0.55 (0.48, 0.64)	0.91 (0.77, 1.09)	0.51 (0.44, 0.60)	1.02 (0.84, 1.25)	0.27* (0.21, 0.34)	0.69* (0.51, 0.92)
Midwest	0.79 (0.70, 0.88)	0.92 (0.79, 1.07)	0.64 (0.56, 0.71)	1.05 (0.89, 1.23)	0.46 (0.40, 0.54)	0.92 (0.76, 1.12)	0.34 (0.28, 0.41)	0.88 (0.69, 1.12)
West	0.77 (0.67, 0.88)	0.90 (0.76, 1.07)	0.58 (0.51, 0.66)	0.95 (0.80, 1.13)	0.46 (0.39, 0.53)	0.91 (0.74, 1.11)	0.33 (0.27, 0.39)	0.84 (0.66, 1.07)
30–39 years	8.98 (8.80, 9.17)		8.80 (8.65, 8.95)		6.71 (6.59, 6.83)		5.06 (4.94, 5.17)	
South	8.74 (8.42, 9.07)	1.00	8.66 (8.39, 8.93)	1.00	6.97 (6.75, 7.19)	1.00	5.09 (4.90, 5.30)	1.00
Northeast	9.60* (9.22, 9.99)	1.10* (1.04, 1.16)	9.22* (8.89, 9.56)	1.06* (1.01, 1.12)	6.82 (6.55, 7.09)	0.98 (0.93, 1.03)	5.10 (4.84, 5.38)	1.00 (0.94, 1.07)
Midwest	9.08 (8.73, 9.43)	1.04 (0.98, 1.10)	8.98 (8.68, 9.29)	1.04 (0.99, 1.09)	6.65 (6.41, 6.90)	0.95 (0.91, 1.00)	5.18 (4.94, 5.43)	1.02 (0.96, 1.08)
West	8.48 (8.08, 8.89)	0.97 (0.91, 1.03)	8.38 (8.07, 8.71)	0.97 (0.92, 1.02)	6.30* (6.06, 6.56)	0.90* (0.86, 0.95)	4.85 (4.61, 5.09)	0.95 (0.89, 1.01)
40–49 years	32.68 (32.33, 33.02)		29.08 (28.77, 29.40)		24.40 (24.16, 24.65)		17.34 (17.14, 17.54)	
South	29.80 (29.21, 30.41)	1.00	27.51 (26.97, 28.05)	1.00	24.59 (24.16, 25.02)	1.00	17.67 (17.33, 18.03)	1.00
Northeast	37.34* (36.61, 38.08)	1.25* (1.22, 1.29)	31.72* (31.02, 32.43)	1.15* (1.12, 1.19)	25.41* (24.86, 25.96)	1.03* (1.00, 1.06)	17.42 (16.97, 17.88)	0.99 (0.95, 1.02)
Midwest	32.41* (31.76, 33.07)	1.09* (1.06, 1.12)	29.72* (29.09, 30.36)	1.08* (1.05, 1.11)	23.86* (23.38, 24.35)	0.97* (0.94, 1.00)	17.29 (16.88, 17.70)	0.98 (0.95, 1.01)
West	31.30* (30.51, 32.11)	1.05* (1.02, 1.09)	27.92 (27.23, 28.63)	1.02 (0.98, 1.05)	23.78* (23.26, 24.31)	0.97* (0.94, 0.99)	16.81* (16.40, 17.24)	0.95* (0.92, 0.98)
20–49 years	14.88 (14.75, 15.02)		13.49 (13.37, 13.61)		11.08 (10.98, 11.18)		7.97 (7.89, 8.05)	
South	13.80 (13.56, 14.04)	1.00	12.89 (12.68, 13.10)	1.00	11.24 (11.07, 11.41)	1.00	8.12 (7.97, 8.26)	1.00
Northeast	16.75* (16.45, 17.04)	1.21* (1.18, 1.24)	14.55* (14.28, 14.83)	1.13* (1.10, 1.16)	11.48 (11.26, 11.70)	1.02 (1.00, 1.05)	7.99 (7.81, 8.18)	0.98 (0.96, 1.01)

All race/ ethnicity	1970–1979 Rate[a] (95% CI)[b]	RR[c] (95% CI)	1980–1989 Rate (95% CI)	RR (95% CI)	1990–1999 Rate (95% CI)	RR (95% CI)	2000–2008 Rate (95% CI)	RR (95% CI)
Midwest	14.82* (14.56, 15.08)	1.07* (1.05, 1.10)	13.79* (13.54, 14.04)	1.07* (1.04, 1.10)	10.86* (10.67, 11.06)	0.97* (0.94, 0.99)	8.00 (7.83, 8.17)	0.99 (0.96, 1.01)
West	14.21* (13.90, 14.53)	1.03* (1.00, 1.06)	12.93 (12.66, 13.20)	1.00 (0.98, 1.03)	10.71* (10.51, 10.92)	0.95* (0.93, 0.98)	7.71* (7.54, 7.88)	0.95* (0.92, 0.98)
Blacks								
20–29 years	1.42 (1.26, 1.59)		1.33 (1.20, 1.47)		1.20 (1.08, 1.34)		0.91 (0.80, 1.03)	
South	1.46 (1.24, 1.72)	1.00	1.39 (1.21, 1.59)	1.00	1.44 (1.25, 1.64)	1.00	0.94 (0.79, 1.11)	1.00
Northeast	1.37 (1.03, 1.77)	0.93 (0.67, 1.28)	1.15 (0.88, 1.47)	0.83 (0.61, 1.10)	0.79* (0.57, 1.05)	0.55* (0.39, 0.76)	0.73 (0.51, 1.02)	0.78 (0.52, 1.13)
Midwest	1.53 (1.18, 1.95)	1.04 (0.77, 1.41)	1.29 (1.01, 1.63)	0.93 (0.70, 1.22)	1.26 (0.98, 1.61)	0.88 (0.66, 1.16)	1.08 (0.81, 1.42)	1.15 (0.82, 1.59)
West	1.02 (0.60, 1.60)	0.69 (0.40, 1.13)	1.42 (1.01, 1.95)	1.02 (0.70, 1.45)	0.67* (0.40, 1.06)	0.47* (0.27, 0.76)	0.73 (0.43, 1.15)	0.77 (0.45, 1.27)
30–39 years	13.08 (12.49, 13.70)		14.49 (13.97, 15.02)		12.92 (12.50, 13.34)		10.65 (10.26, 11.05)	
South	13.17 (12.32, 14.07)	1.00	15.26 (14.52, 16.03)	1.00	13.68 (13.10, 14.28)	1.00	11.39 (10.84, 11.96)	1.00
Northeast	12.07 (10.90, 13.34)	0.92 (0.81, 1.03)	13.09* (12.03, 14.23)	0.86* (0.78, 0.95)	11.34* (10.47, 12.27)	0.83* (0.76, 0.91)	8.69* (7.88, 9.55)	0.76* (0.68, 0.85)
Midwest	13.72 (12.40, 15.15)	1.04 (0.92, 1.17)	14.18 (13.03, 15.41)	0.93 (0.84, 1.02)	12.76 (11.80, 13.77)	0.93 (0.85, 1.02)	10.81 (9.87, 11.81)	0.95 (0.86, 1.05)
West	13.71 (11.67, 15.99)	1.04 (0.87, 1.23)	13.92 (12.29, 15.71)	0.91 (0.80, 1.04)	12.15* (10.87, 13.54)	0.89* (0.79, 1.00)	10.04 (8.81, 11.38)	0.88 (0.77, 1.01)
40–49 years	38.51 (37.45, 39.60)		41.33 (40.30, 42.37)		40.03 (39.20, 40.87)		32.73 (32.05, 33.42)	
South	36.83 (35.36, 38.35)	1.00	41.02 (39.57, 42.51)	1.00	41.14 (39.99, 42.32)	1.00	34.02 (33.09, 34.42)	1.00
Northeast	41.66* (39.31, 44.12)	1.13* (1.05, 1.21)	39.72 (37.58, 41.95)	0.97 (0.91, 1.03)	36.31* (34.56, 38.13)	0.88* (0.83, 0.93)	28.80* (27.33, 30.34)	0.85* (0.80, 0.90)
Midwest	39.32 (36.98, 41.77)	1.07 (0.99, 1.15)	43.07 (40.71, 45.54)	1.05 (0.98, 1.12)	40.57 (38.65, 42.57)	0.99 (0.93, 1.04)	33.98 (32.33, 35.69)	1.00 (0.94, 1.06)
West	38.33 (34.60, 42.35)	1.04 (0.93, 1.16)	43.25 (39.72, 47.01)	1.05 (0.96, 1.15)	40.46 (37.69, 43.38)	0.98 (0.91, 1.06)	30.61* (28.45, 32.89)	0.90* (0.83, 0.97)
20–49 years	18.55 (18.12, 18.99)		20.00 (19.59, 20.41)		18.96 (18.63, 19.29)		15.51 (15.23, 15.80)	
South	18.00 (17.40, 18.62)	1.00	20.18 (19.61, 20.77)	1.00	19.69 (19.23, 20.16)	1.00	16.23 (15.85, 16.63)	1.00
Northeast	19.29* (18.36, 20.26)	1.07* (1.01, 1.14)	18.90* (18.05, 19.77)	0.94* (0.89, 0.99)	16.98* (16.28, 17.69)	0.86* (0.82, 0.90)	13.39* (12.79, 14.01)	0.83* (0.78, 0.87)

All race/ethnicity	1970–1979		1980–1989		1990–1999		2000–2008	
	Rate[a] (95% CI)[b]	RR[c] (95% CI)	Rate (95% CI)	RR (95% CI)	Rate (95% CI)	RR (95% CI)	Rate (95% CI)	RR (95% CI)
Midwest	19.09 (18.13, 20.08)	1.06 (1.00, 1.13)	20.50 (19.57, 21.46)	1.02 (0.96, 1.07)	19.11 (18.35, 19.90)	0.97 (0.93, 1.02)	16.06 (15.38, 16.76)	0.99 (0.94, 1.04)
West	18.58 (17.07, 20.18)	1.03 (0.94, 1.13)	20.51 (19.13, 21.96)	1.02 (0.94, 1.09)	18.69 (17.60, 19.82)	0.95 (0.89, 1.01)	14.50* (13.61, 15.42)	0.89* (0.83, 0.95)

[a] Rates are per 100,000 population and are age-adjusted to the 2000 U.S. standard population (Day JC, U.S. Census Current Population Reports No. 25-1130. 1996.)

[b] Confidence intervals (CI) (Tiwari mod) are 95% for rates and ratios.

[c] Rate ratio (RR): rates by three geographic regions (i.e., Northeast, Midwest, and West) compared to the South, the reference region. The states that make up of these regions are:

South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia;

Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont;

Midwest : Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin; and

West : Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

*The rate ratio indicates that the rate is significantly different from the rate for the South (2-sided $p<0.05$).

Appendix C

Trends in breast cancer mortality rates among young women by race/ethnicity, age group, and geographic region, U.S., 1970–2008

Age group, years	Geographic region	Rate[a] 1970–2008	APC[b] 1970–2008	Joinpoint Analysis Trend 1 Year	Trend 1 APC[b]	Trend 2 Year	Trend 2 APC[b]	Trend 3 Year	Trend 3 APC[b]	Trend 4 Year	Trend 4 APC[b]
All race/ ethnicity											
20–29		0.64	−2.42*	1970–2008	−2.44*	---	---	—	—	—	—
	South	0.73	−1.99*	1970–2008	−2.00*	—	—	—	—	—	—
	Northeast	0.60^	c	1970–2008	c	—	—	—	—	—	—
	Midwest	0.64^	−2.33*	1970–2008	−2.33*	—	—	—	—	—	—
	West	0.53^	c	1970–2008	c	—	—	—	—	—	—
30–39		7.79	−1.73*	1970–1987	−0.15	1987–2008	−2.86*	—	—	—	—
	South	8.27	−1.41*	1970–1977	−2.76*	1977–1987	1.65*	1987–2008	−2.79*	—	—
	Northeast	7.91^	−2.01*	1970–1986	−0.32	1986–2008	−3.14*	—	—	—	—
	Midwest	7.84^	−1.74*	1970–1986	−0.03	1986–2008	−2.84*	—	—	—	—
	West	6.93^	−1.99*	1970–1984	−0.04	1984–2008	−2.76*	—	—	—	—
40–49		25.89	−1.78*	1970–1982	−1.39*	1982–1990	0.23	1990–2008	−3.27*	—	—
	South	26.16	−1.31*	1970–1980	−1.29*	1980–1991	0.65	1991–2008	−3.00*	—	—
	Northeast	27.68^	−2.24*	1970–1991	−1.35*	1991–2008	−3.61*	—	—	—	—
	Midwest	26.02	−1.82*	1970–1990	−0.70*	1990–2008	−3.21*	—	—	—	—
	West	23.44^	−1.94*	1970–1982	−1.63*	1982–1990	0.52	1990–2008	−3.59*	—	—
Whites											
20–29		0.56	−2.81*	1970–2008	−2.80*	—	—	—	—	—	—
	South	0.58	−2.58*	1970–2008	−2.59*	—	—	—	—	—	—
	Northeast	0.56	c	1970–2008	c	—	—	—	—	—	—
	Midwest	0.57	c	1970–2008	c	—	—	—	—	—	—
	West	0.53^	c	1970–2008	c	—	—	—	—	—	—
30–39		7.26	−2.00*	1970–1987	−0.39	1987–2008	−3.23*	—	—	—	—
	South	7.21	−1.85*	1970–1977	−2.70*	1977–1987	1.02	1987–2008	−3.31*	—	—
	Northeast	7.64^	−2.18*	1970–1985	−0.35	1985–2008	−3.29*	—	—	—	—
	Midwest	7.41^	−1.93*	1970–1986	−0.10	1986–2008	−3.16*	—	—	—	—
	West	6.79^	−2.08*	1970–1984	0.04	1984–2008	−2.97*	—	—	—	—
40–49		24.85	−2.02*	1970–1983	−1.49*	1983–1990	0.21	1990–2008	−3.68*	—	—
	South	23.96	−1.68*	1970–1983	−1.18*	1983–1991	0.96	1991–1999	−4.46*	1999–2008	−2.59*
	Northeast	27.26^	−2.36*	1970–1991	−1.41*	1991–2008	−3.92*	—	—	—	—
	Midwest	25.00^	−2.02*	1970–1990	−0.85*	1990–2008	−3.52*	—	—	—	—
	West	23.58^	−2.04*	1970–1982	−1.75*	1982–1990	0.52	1990–2008	−3.80*	—	—
Blacks											
20–29		1.21	−1.58*	1970–1977	−10.14*	1977–1980	14.20	1980–2008	−1.91*	—	—
	South	1.30	−1.24*	1970–2008	−1.24*	—	—	—	—	—	—
	Northeast	0.99^	c	1970–2008	c	—	—	—	—	—	—

Age group, years	Geographic region	Rate[a] 1970–2008	APC[b] 1970–2008	Joinpoint Analysis Trend 1 Year	Trend 1 APC[b]	Trend 2 Year	Trend 2 APC[b]	Trend 3 Year	Trend 3 APC[b]	Trend 4 Year	Trend 4 APC[b]
	Midwest	1.28	c	1970–2008	c	—	—	—	—	—	—
	West	0.96^	c	1970–2008	c	—	—	—	—	—	—
30–39		12.64	–0.80*	1970–1983	0.07	1983–1986	6.27	1986–2008	–2.16*	—	—
	South	13.27	–0.69*	1970–1980	–1.11	1980–1986	4.88*	1986–2008	–2.06*	—	—
	Northeast	11.16^	–1.14*	1970–1987	1.24	1987–2008	–2.70*	—	—	—	—
	Midwest	12.72	–0.86*	1970–2008	–0.86*	—	—	—	—	—	—
	West	12.17^	–1.10*	1970–2008	–1.11*	—	—	—	—	—	—
40–49		37.48	–0.63*	1970–1977	–0.88	1977–1991	1.16*	1991–2008	–2.26*	—	—
	South	37.83	–0.39*	1970–1977	–2.08	1977–1989	2.57*	1989–2008	–2.01*	—	—
	Northeast	35.59^	–1.26*	1970–1992	–0.52	1992–2008	–2.34*	—	—	—	—
	Midwest	38.70	–0.57*	1970–1987	1.12*	1987–2008	–1.63*	—	—	—	—
	West	37.13	–0.93*	1970–1996	0.55	1996–2008	–4.68*	—	—	—	—

[a] Rates are per 100,000 and age–adjusted to the 2000 U.S. standard population (Day JC, U.S. Census Current Population Reports No. 25–1130. 1996.)

[b] The annual percentage change (APC) was calculated using weighted least squares method.

[c] Statistic could not be calculated.

*The APC is statistically significantly different from 0 (2–sided $p < 0.05$).